

STUDY OF CHILDREN'S EYE MOVEMENTS DURING READING

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Introduction

Already in 1981 Pavlidis et al. found that children with dyslexia in reading tasks perform shorter saccades, longer fixations and more regressions. Biscaldi (1998), De Luca (1999), Hutzler (2006) have observed that in tasks with less cognitive demand eye movements are more similar to a control group [1,2]. Stein (2000), Fisher (2000), Aring (2007) found that dyslectics tend to have unstable binocular fixation what can cause visual confusion during reading – letters may seem to move around, flip, merge and jump over each other [3]. Reading difficulties are a current problem, so it is important to understand whether there are any particular text processing principles that facilitate both oculomotor control and cognitive mechanism in reading. The objective of the research is to ascertain if the influence of Gestalt grouping principles exists in reading and its dependence of children reading skills.

Participants

The study involved two children (age 9) – C with good reading skills and A with poor reading skills and one adult as a control. The task demands child's prolonged attention to stare at the stimuli and patience to maintain stable head position. Ability to communicate with a child and motivate him influences experimental process.

Stimuli

Texts with different word layout and text processing were made as stimuli (see fig.1). To maintain context, chosen text was a part of fairy-tale, appropriate to children's age. To keep attention, two images with difference search task were shown after text No.4. Fixation point was demonstrated after each text, but after an image 10sec long point (size 0,3°) was shown to evaluate fixation stability.

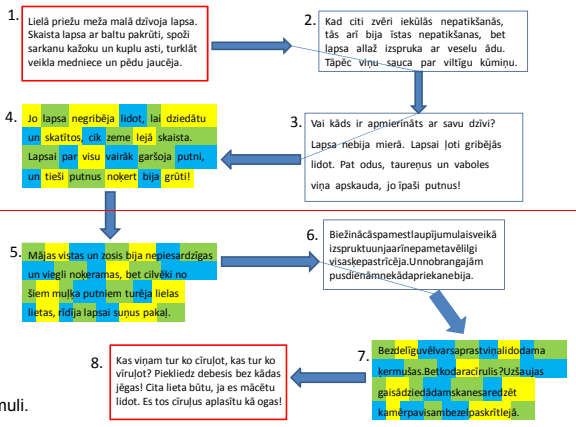


Fig.1. Stimuli.

Method

To detect eye movements *iViewX Hi-Speed 240Hz (SMI, Germany)* eye tracker was used. Data were processed in *BeGaze*. A velocity-based saccade detection algorithm was used to define saccades and fixations. Because of great amount of invalid data, manual data selection and correction was made, excluding blinks, reflex errors. For analysis we took two middle lines of each text. Data analysis was made in *MsExcel*. Participants were looking to screen binocularly, but recorded was right eye. To maintain stable head position chin support and front support was used. For children if necessary we used an additional chin support or front support to adjust child's head position.

Summary

1) Child with poor reading skills has higher dispersion of gaze position during single point fixation than child with good reading skills and adult. It means that amount of dispersion correlates with reading skills.
2) Poor reader shows abnormally short saccades and long, unstable fixations. Reading is like moving across the text with low amplitude eye movements.
3) All participants have influence of grouping principles to eye movements. Child and adult show more difference in saccade amplitude. Poor reader has similar eye movement characteristics in all texts – with no successive saccades and fixations. Grouping principles doesn't significantly facilitate ability to read each word. However, good readers even can show successive saccades and fixations during reading text without spaces. Word can be considered as strong grouping principle.

Results

To understand the text qualities influence and reading skills influence to reading process, amplitude of saccades, fixation duration were analyzed. Data about gaze position in single point fixation was used to understand fixation characteristics in participants.

Differences in saccade amplitude and fixation duration during reading were found. For child C and adult saccade amplitude is longer if the reading task is facilitated by text layout, and it is twice shorter when spaces are removed from the text. But in all texts child C and adult have normal distribution of saccades and fixations. Average saccade amplitude and fixation duration for child C is 1,71° and 178ms in text No.1; 0,95° and 344ms in text No.6. Child A has abnormal gaze shifts in all texts. Average saccade amplitude is ~1° or less, which includes 3 or fewer letters (while in normal reading saccade should include 5-8 letters). Average saccade amplitude and fixation duration is 0,83° and 480ms in text No.1; 0,79° and 866ms in text No.6. Child C reads normal text 3 times faster than text No.6, while child A shows small difference in both texts reading time. See fig.2

Children A and C, texts No.1 and No.6

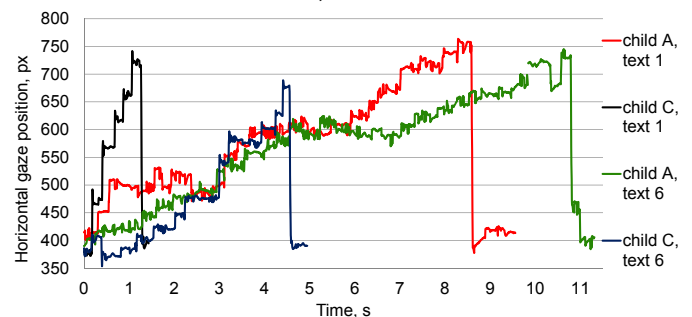


Fig.2. Horizontal gaze position changes during reading one line of texts.

Contour graphs in fig.3 show how gaze position distributes in area inspected during point fixation. During the fixation both adult and child C more than 71% of gaze position direct to area of dimensions 1,5° (500px²). However, child A in the same area directs only half (54%) of gaze position points. For reaching 71% gaze position he needs much larger area – 800px².

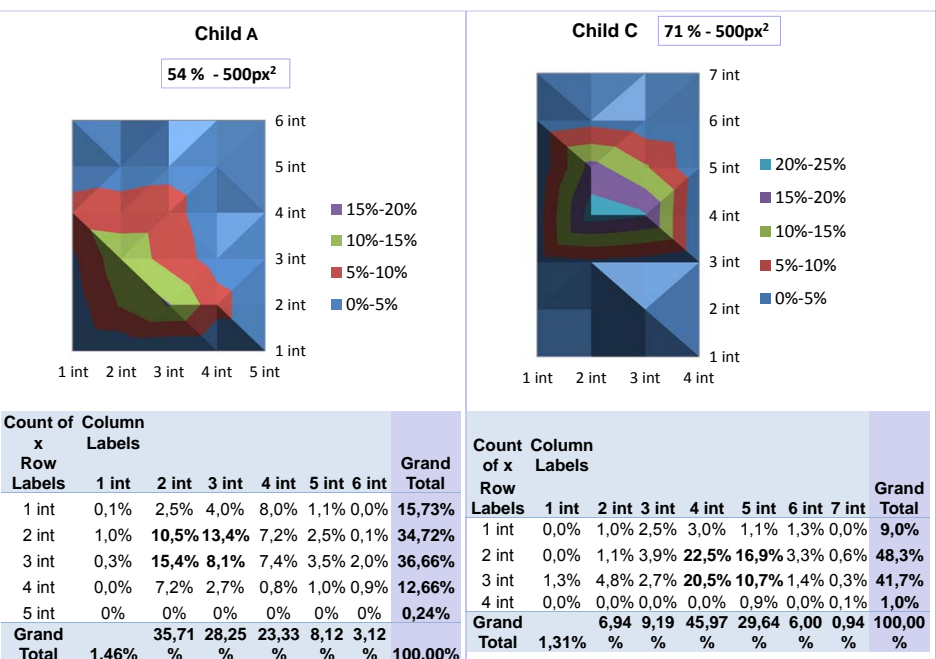


Fig.3. Distribution of gaze position during fixation. Size of one interval is 10px.